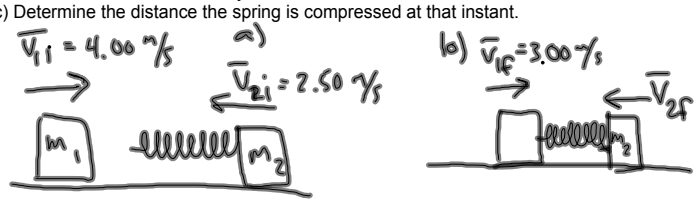
Collision Notes and Practice Problems 10.6.11 AP Physics

A block of mass 1.60 kg initial moving to the right with a speed of 4.00 m/s on a frictionless, horizontal track collides with a spring attached to a second block of mass 2.10 kg initial moving to the left with a speed of 2.50 m/s. The spring constant is 600 N/m.
a) Find the velocities of the two blocks after the collision.
b) During the collision, at the instant block 1 is moving to the right with a velocity of + 3.00 m/s, determine the velocity of block 2.
c) Determine the distance the spring is compressed at that instant.



a) $m_1\bar{v}_{1i} + m_2\bar{v}_{2i} = m_1\bar{v}_{1f} + m_2\bar{v}_{2f}$

$\frac{1}{2}m_1v_{1i}^2 + \frac{1}{2}m_2v_{2i}^2 = \frac{1}{2}m_1v_{1f}^2 + \frac{1}{2}m_2v_{2f}^2$

$\frac{1}{m_1}(m_1v_{1i} + m_2v_{2i} - m_2v_{2f}) = v_{1f}$

$v_{1f} = -3.38$ m/s

$v_{2f} = 3.12$ m/s

$m_1v_{1i}^2 + m_2v_{i2}^2 = m_1\left[\frac{1}{m_1}(m_1v_{1i} + m_2v_{2i} - m_2v_{2f})\right]^2 + m_2v_{2f}^2$

$m_1v_{1i}^2 + m_2v_{i2}^2 = m_1\left[(v_{1i} + \frac{m_2}{m_1}v_{2i}) - \frac{m_2}{m_1}v_{2f}\right]^2 + m_2v_{2f}^2$

$= m_1\left[(v_{1i} + \frac{m_2}{m_1}v_{2i})^2 - 2(v_{1i} + \frac{m_2}{m_1}v_{2i})(\frac{m_2}{m_1}v_{2f}) + (\frac{m_2}{m_1})^2v_{2f}^2\right] + m_2v_{2f}^2$

$= m_1(v_{1i} + \frac{m_2}{m_1}v_{2i})^2 - 2m_1(v_{1i} + \frac{m_2}{m_1}v_{2i})(\frac{m_2}{m_1}v_{2f}) + m_1(\frac{m_2}{m_1})^2v_{2f}^2 + m_2v_{2f}^2$

b) $\bar{P}_{1i} + \bar{P}_{2i} = \bar{P}_{1f} + \bar{P}_{2f}$

$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$

$v_{2f} = \frac{m_1v_{1i} + m_2v_{2i} - m_1v_{1f}}{m_2}$

$= -1.74$ m/s

c) $E_i = E_f$

$U_{sf} = \frac{1}{2}kx_f^2$

$\Delta K_{1i} + \Delta K_{2i} + U_{si} = \Delta K_{1f} + \Delta K_{2f} + U_{sf}$

$x_f = \sqrt{\frac{2}{k}\left[\left(\frac{1}{2}m_1(v_{1i}^2 - v_{1f}^2)\right) + \left(\frac{1}{2}m_2(v_{2i}^2 - v_{2f}^2)\right)\right]}$

$= 0.173$ N/m

$$m_1 v_{1i}^2 + m_2 v_{i2}^2 = m_1\left[\left(v_{1i} + \frac{m_2}{m_1} v_{2i}\right) - \frac{m_2}{m_1} v_{2f}\right]^2 + m_2 v_{2f}^2$$

$$= m_1\left(v_{1i} + \frac{m_2}{m_1} v_{2i}\right)^2 - 2m_1\left(v_{1i} + \frac{m_2}{m_1} v_{2i}\right)\left(\frac{m_2}{m_1} v_{2f}\right)$$

$$+ m_1\left(\frac{m_2}{m_1}\right)^2 v_{2f}^2 + m_2 v_{2f}^2$$

HW:

p. 262: 19, 23, 24, 26

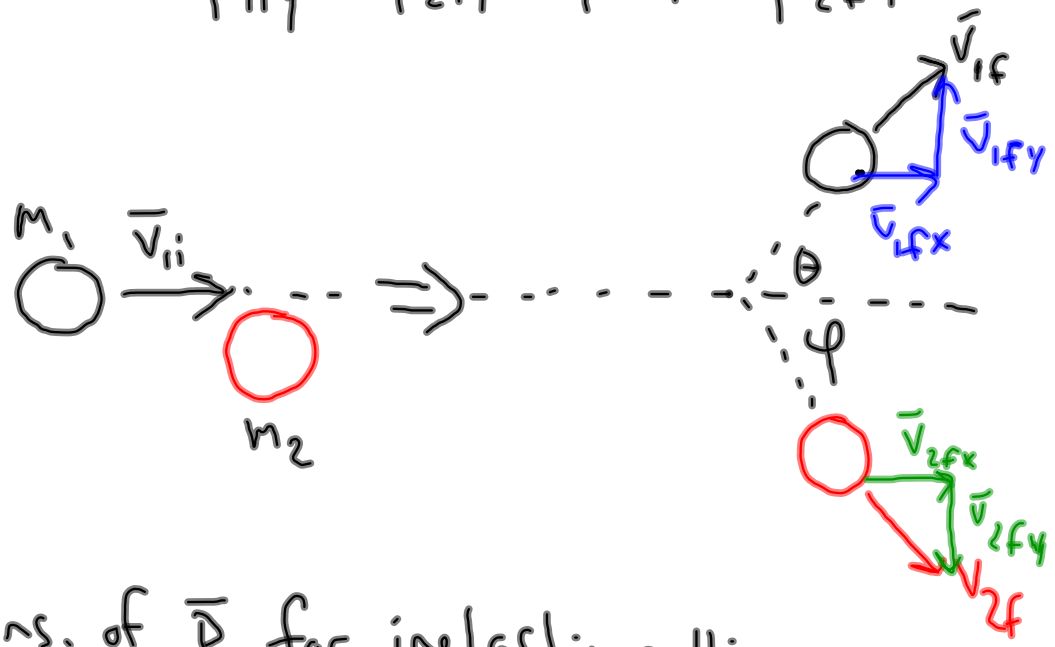
Collisions in 2-Dimensions:

- Still use conservation of momentum and collision types

- Cons. of $\bar{p}$ for elastic collision:

$$\bar{P}_{1ix} + \bar{P}_{2ix} = \bar{P}_{1fx} + \bar{P}_{2fx}$$

$$\bar{P}_{1iy} + \bar{P}_{2iy} = \bar{P}_{1fy} + \bar{P}_{2fy}$$

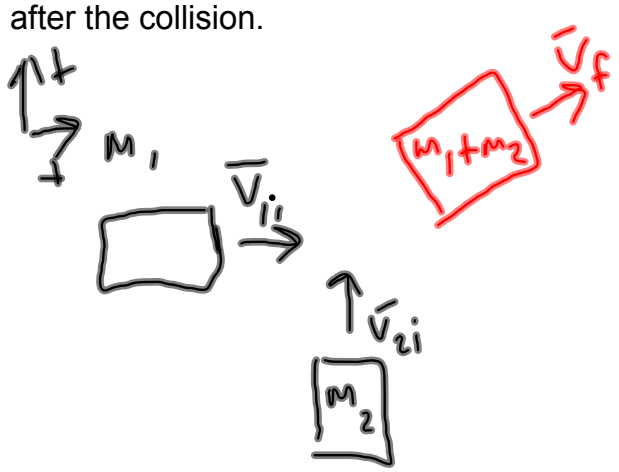


- Cons. of $\bar{p}$ for inelastic collision:

$$\bar{P}_{1x} + \bar{P}_{2x} = (m_1 + m_2)\bar{v}_{fx}$$

$$\bar{P}_{1y} + \bar{P}_{2y} = (m_1 + m_2)\bar{v}_{fy}$$

A 1500 kg car traveling east with a speed of 25.0 m/s collides at an intersection with a 2500 kg van traveling north at a speed of 20.0 m/s. Find the direction and magnitude of the velocity of the wreckage after the collision, assuming the vehicles stick together after the collision.

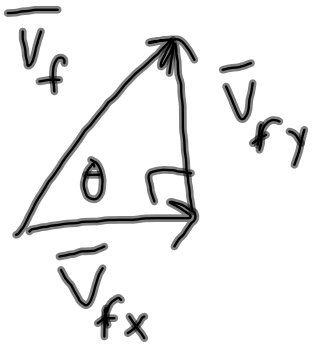


$$m_1 \bar{v}_{1ix} + m_2 \bar{v}_{2ix} = (m_1 + m_2) \bar{v}_{fx}$$

$$v_{fx} = \frac{m_1 v_{1ix}}{m_1 + m_2} = 9.38 \text{ m/s}$$

$$m_1 \bar{v}_{1iy} + m_2 \bar{v}_{2iy} = (m_1 + m_2) \bar{v}_{fy}$$

$$v_{fy} = \frac{m_2 v_{2iy}}{m_1 + m_2} = 12.5 \text{ m/s}$$

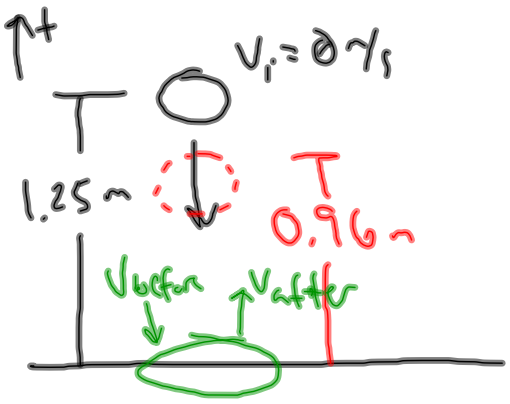


$$v_f = 15.6 \text{ m/s}$$

$$\theta = 53^\circ$$

North of East

#8, p. 261: $m = 0.15\ kg$



find $\bar{J}$

givens: m, h_i, h_f, v_i

$\bar{J} = \bar{F}\Delta t = \Delta\bar{p} = m\Delta\bar{v}$

$\bar{J} = m(v_f - v_i)$

$\frac{1}{2}mv_i^2 + mgh_i = \frac{1}{2}mv_f^2 + mgh_f$

$\bar{J} = m(v_{after} - v_{before})$

$= 0.15\ kg\left[4.34\ m/s - (-4.95\ m/s)\right]$

$= 1.4\ kg \cdot m/s$

To find v_{before}:

$\frac{1}{2}m\cancel{v_i^2}^{0} + mgh_i = \frac{1}{2}mv_{before}^2 + \cancel{mgh_f}^{0}$

$v_{before} = \pm\sqrt{2gh_i} = -4.95\ m/s$

To find v_{after}:

$\frac{1}{2}mv_{after}^2 + \cancel{mgh_i}^{0} = \cancel{\frac{1}{2}mv_f^2}^{0} + \cancel{mgh_f}$

$v_{after} = \pm\sqrt{2gh_f} = +4.34\ m/s$